

A Staff Report on:
**AIR QUALITY AND ECONOMIC EFFICIENCY IN A
RESTRUCTURED ELECTRICITY MARKET**

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INTRODUCTION: AIR QUALITY AND REGULATION IN A RESTRUCTURED ELECTRICITY MARKET

As air quality regulators seek to meet increasingly costly air quality goals, they have begun to look at incentive-based regulations as a more flexible, lower cost alternative. In *ER 94*, the California Energy Commission (CEC) recommended the establishment of broadly-based, market-oriented environmental policies as a way to improve the balancing of social costs and benefits.¹ By inducing environmentally efficient choices with less government interference, the regulatory system can be more responsive, meeting air quality goals faster and at lower cost. This staff report is in support of this effort, as well as the *ER 96* Committee Hearings on Environmental Effects.

With the restructuring of the electricity industry, which makes many of the traditional planning mechanisms for balancing environmental and economic concerns obsolete, rules that adapt to economic change become especially valuable. Structural and operational change in energy markets will affect the location, level, and profile of emissions from generation. If air quality management districts rely on the three-year air quality planning cycle, they may identify needed control measures only after firms have made siting and operations decisions. Rather than reacting to change, districts can use financial incentives to help ensure *ex ante* that these decisions account for environmental costs. The regulator does not have to rely on costly, retrospective, source-specific rule-making, and businesses will consider environmental costs in a consistent way, resulting in economically and environmentally efficient growth throughout the state.

The benefits of moving to an incentive-based system depend in part on current inefficiencies. This paper first reviews the principles of well-designed incentive programs, and second, discusses the extent to which current regulations are consistent with these principles. Finally, we review alternatives for using incentive-based regulatory strategies for air quality control. This paper focuses on criteria pollutants, as these are the responsibility of the state and districts, and present the greatest immediate challenge in light of restructuring. Although this paper emphasizes issues for the electricity generation sector, the principles discussed apply to all sources.

¹ 1994 *Electricity Report*, California Energy Commission, November 1995, P300-95-002, pp. 63-64.

AIR QUALITY PROTECTION AND ECONOMIC EFFICIENCY

Incentives versus “Command and Control”

Environmental regulation in the United States has traditionally relied primarily on standards or limits, set by regulators, and applied more or less uniformly to broad classes of sources. In air quality, regulators identify the available control technologies and set the standard based on what is deemed reasonably cost-effective. If the regulator had perfect information about costs and could establish appropriate limits for each individual facility, this system might work acceptably. Of course, for any given source class, processes, plant configurations, and costs vary immensely. Regulators with limited budgets cannot acquire all this facility-specific information. The sources themselves have the best information about their own operations and what particular control strategy will work best for them, but have a disincentive to reveal that information. The benefit of incentive-based strategies is that they construct an environment in which it is in the firm's best interest to find the most efficient way to reduce emissions. Once the regime is set up, the regulator does not need to know how cost-effective different control options will be, or the cost at a particular installation.

When most major sources were doing little to reduce emissions, there seemed scant reason to doubt that emission control requirements were cost-effective. Now, however, some sources have been quite heavily regulated while others have done much less. Control costs have risen rapidly in some industries, illustrating one of the problems created by government's imperfect information about the best opportunities for emission reductions.

The reliance on individual motivation under incentive-based rules can lower the total cost to society of achieving and maintaining healthy air. The key feature of a socially efficient strategy is that for each firm (or individual), the marginal cost faced by the firm for its emissions equals the total of marginal costs that it imposes on other firms and individuals. For most goods, this condition holds because the price paid for other inputs equals the marginal cost to another firm of supplying it, and the firm chooses to use the efficient amount. Because pollution is under- or un-priced, firms use it in excess. Policies such as surcharges for emissions or marketable permits seek to create the missing market or price for pollution. When sources must pay a price for each unit of emissions, they make socially beneficial production decisions without regulatory mandates.

In the traditional regulatory process, the CEC and the California Public Utilities Commission (CPUC) used the planning and review process to try to incorporate environmental values into powerplant siting decisions. But because no mechanism existed for incorporating those costs into the decision calculus of the utilities, benefits were not fully realized. The marginal social cost of emissions remained “external” to the firm's private cost. This is why what is referred to as “planning-based internalization” does not effectively “internalize,” or incorporate social costs into the source's private costs. Policies that use “command and control” restrictions on location and operations can reduce the social cost of emissions, but they will miss opportunities for cost-saving because they don't alter the incremental cost of powerplant operation.

Setting the Target

All air quality policy options, whether markets, charges, or performance standards, include either an explicit or implicit choice of the optimal level of ambient air quality. The economic definition of the efficient level of emissions is at the point where, in equilibrium, the sum of marginal control costs equals the sum of marginal damages. Marginal damages, or the marginal benefit from reduced emissions, can be defined as the marginal willingness to pay of those harmed by air pollution, or how much they value an improvement in air quality. This will reflect health effects, loss of

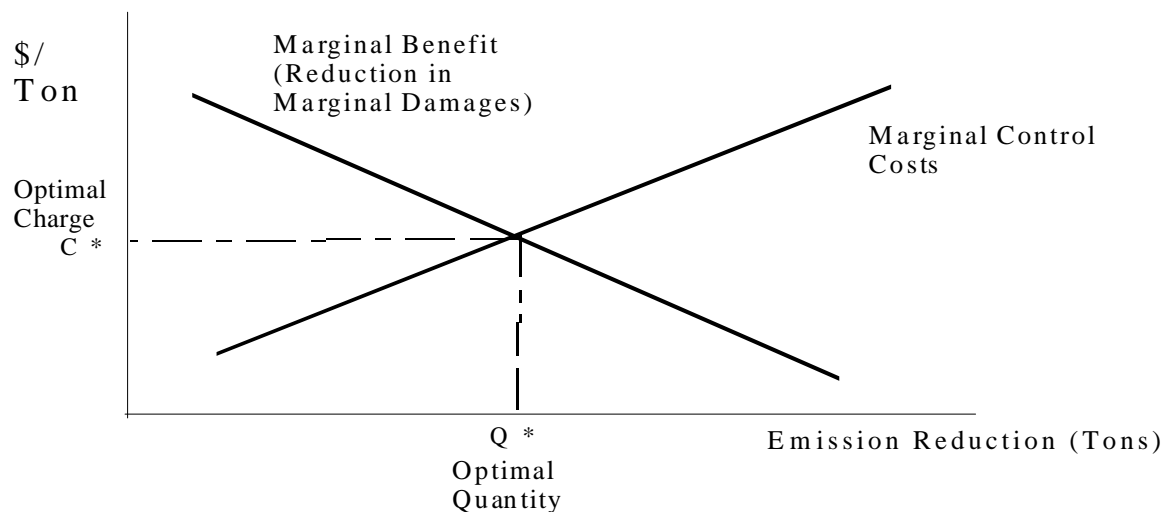


Figure 1: Selecting the Efficient Emission Charge or Cap:

The regulator can either set emission charge C^* , which will result in Q^* tons of emission reduction, or allocate emission reduction requirements of Q^* , which will result in a market price of C^* .

productivity or leisure, and other preferences. The marginal cost curve represents the least-cost combination of inputs (such as labor, fuel and equipment) to achieve a given level of air quality. In theory, the regulator tries to set the emission charge, or allocate permits, at this level. These curves (illustrated in Figure 1) represent the long-run path of costs and benefits as we reduce emissions, reflecting changes in relative prices of all goods as the economy moves to a new equilibrium with lower emissions. When a firm's private cost is changed to include marginal damages of emissions, it is reflected in the firm's production and pricing decisions. Thus prices of goods and services will reflect marginal private and damage costs. As relative prices of competing products change, the composition of goods and services in the economy will also adjust.

To identify the emission charge or the cap on total emissions, “we need measures not only of existing damages and control costs, but we need to develop measures of the incremental costs and benefits over a substantial range. The proper price is not equal to marginal social damages at *existing* level of pollution; it is a charge equal to marginal damages *at the optimal outcome*.”² Because we currently rely mainly on inefficient control strategies, we are not on the least-cost curve; we are at some point above the marginal cost curve in Figure 1. Therefore we cannot tell from existing costs and benefits what the charge or emission cap should be; the optimal tax or quantity shown in Figure 1 is unknown. We can set the level where the charge equals current marginal damages in the hopes of converging to the optimal level, but because we do not know the combination of inputs and outputs that characterize the “optimum,” we do not know whether a change in the charge rate has moved us closer. If we base charges on current damages, we are moving toward an unknown target. For example, assume that each ton of emissions from powerplants currently causes \$100 in damage, but that after all efficient investments are made in add-on equipment and boiler tuning, resulting in a different dispatch of powerplants and lower total emissions, marginal damage would be only \$50 per ton. A charge of \$100 per ton would result in excessive investment in reducing emissions, beyond what is efficient.

Improved understanding of control costs and environmental damages can be valuable in informing policy choices, but the difficulties above suggest that the choice of target might best be made through a collective choice process. A “second best” approach is to select in advance the ambient standard we wish to attain, and design rules to meet it. Given this target, we can design policies to meet the goal most efficiently, and we can tell from current emissions whether we are moving toward the goal. While we may not

² M. L. Cropper and W. E. Oates, “Environmental Economics: A Survey,” 30 *J. of Economic Literature* 675, June 1992.

be maximizing “social welfare,” the benefits from this approach should be compared not to the theoretical optimum, but what we could actually achieve through an alternative strategy. If the policy variable chosen is a charge, a great deal of information is still required about marginal cost curves — not just current marginal costs — to identify the charge that will result in the desired target.

The federal and state laws for selecting ambient standards are often criticized for excluding consideration of costs. While one policy option to provide air quality more efficiently is to improve the process for selecting ambient standards, this would still leave the central question of how best to meet those standards. For individual air districts that must make progress toward state and federal standards, taking an established ambient standard as the target may be a more realistic approach than relying on estimates of marginal damage curves.

This paper assumes that an ambient standard is selected through some appropriate means, and addresses options for meeting that standard efficiently. For the selected level of air quality, we can compare policy alternatives as to whether they are likely to minimize the costs of achieving that standard. The particulate matter and ozone ambient standards may be changed within the next few years ³. By making the air quality regulatory system more efficient, we will be in a position to meet new, possibly more stringent standards faster, at a lower cost, and with less opposition from regulated sources.

Principles of Efficient Incentive Programs

Incentive-based regulations can be powerful tools for ensuring the most cost-effective use of all resources, including environmental. When those who use natural resources bear a cost in proportion to what they impose on others, efficiency is improved in two ways.

First, in the short-run, the ambient standard is met at minimum cost. The least-cost strategy for achieving an air quality standard for a given air shed is achieved when marginal costs of control are equal across all sources, assuming they all contribute equally to damages. If marginal control costs are not equal, opportunities exist to lower costs by having sources with lower costs reduce emissions more, and high-cost sources less. If meteorology causes sources in certain locations to make a greater contribution

³ For a discussion of proposed changes in the ambient standards, see “Staff Report on State and District Air Quality Planning: Trends and Restructuring Implications,” June 18, 1996.

to air quality degradation, then an efficient rule would impose a higher marginal cost on emissions from those locations. Thus each source's marginal cost per unit of damage would be equal, and product prices for all goods would reflect environmental damage. An emission charge would accomplish this by charging for each unit of emissions, with the charge varying by location of the source. A market of tradeable emission credits could allow trading across all sources in the air shed, but impose "transfer coefficients" that would reflect varying marginal damages by location.

Second, in the long-run, an efficient rule gives businesses correct entry and exit incentives and continuous incentives to invest in and adopt clean technologies. The long-run requirement for efficiency is that total payments or opportunity costs borne by each firm equal total damages from that firm.⁴ When firms bear the total costs of their actions, then siting, operation, and shutdown decisions lead to the efficient number and type of firms, with appropriate investments in new strategies for pollution reduction or prevention. At any given time the capability of current technology, and hence the growth that can be absorbed without increasing emissions, is limited. In the face of potentially more stringent air quality ambient standards, the impact of policies on the development and spread of new technologies is crucial to improving air quality and allowing economic growth simultaneously.

In practice, most policy options neither completely fail to internalize the social costs of emissions into private costs of sources, nor fully internalize. Policies fall onto a continuum from those that provide perverse incentives (e.g., the disincentive from control technology requirements to invest in control technology development for fear of ratcheting up the technology standard), those that provide limited incentives to minimize costs (source-specific performance standards that allow a choice of compliance strategies), to those that provide strong incentives to minimize costs and invest in technology (RECLAIM⁵). All existing incentive-based programs impose constraints for consistency with federal and state requirements. The appropriate extent of "internalization" also depends on the potential net benefits. If implementation and transaction costs are high, program costs could outweigh air quality benefits. "Internalization" is a means to an end; the goal is an efficient balancing of social costs

⁴ "Opportunity cost" refers to the cost of using a resource even though there is no out-of-pocket cost. For example, existing sources in the RECLAIM emission credit market received initial allocations of credits for free, but their opportunity cost of using a credit to cover emissions is the revenue forgone from sale - whatever the current market price is.

⁵ The Regional Clean Air Incentives Market (RECLAIM) is an emissions trading program for major sources of NO_x and SO_x in the South Coast Air Quality Management District (SCAQMD).

and benefits.

Given the limitations of knowledge and political processes, what policy makers can do is identify whether net social benefits can be increased by improving the regulatory environment. In the past, the cost of permitting and monitoring led districts to focus on larger stationary sources, and require few controls on small or area sources. Districts now face diminishing returns from more stringent requirements for large sources. Control costs vary widely across controlled sources, while other sources face no controls at all. The challenge many regulators now face is to induce reductions from these many sources in a more cost-effective manner.

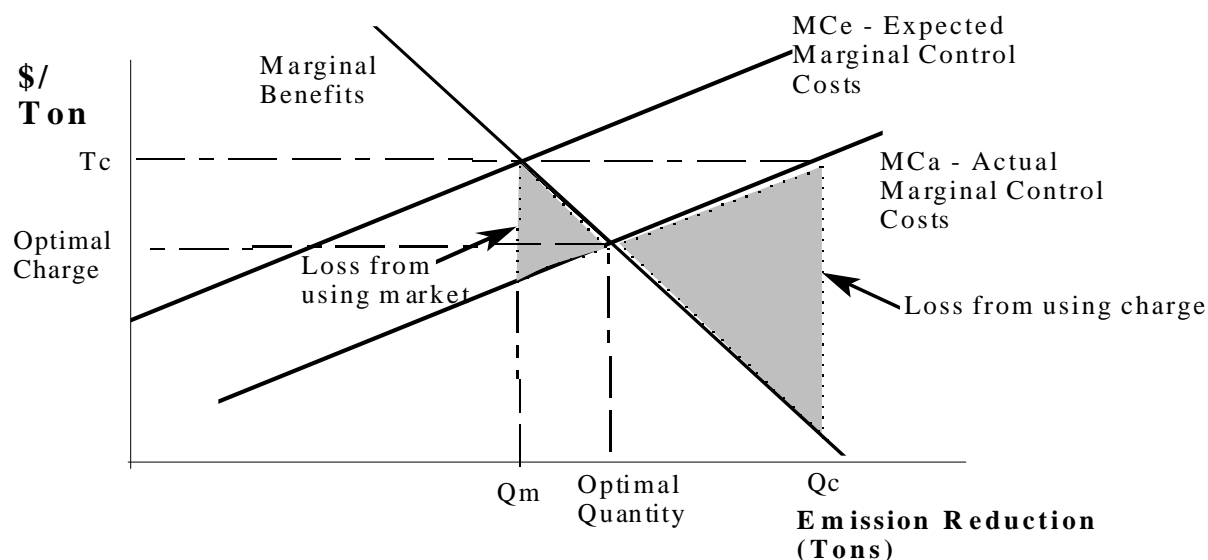


Figure 2: The Social Cost of Uncertainty about Control Costs :

Shaded areas represent inefficiency from using a charge versus a market, when costs are overestimated, assuming the marginal benefit curve is relatively steep.

Choosing the Policy Instrument

Most incentive mechanisms for affecting a source's marginal cost fall into one of two general categories: prices (emission charges) and quantities (emission caps with marketable permits). Under either approach, a firm will evaluate the marginal cost of emitting and, for a given level of production, choose the least cost strategy — that which minimizes both control costs and cost of polluting (paying a charge or buying emission credits.) In a short-run, static sense the two measures are equivalent and in

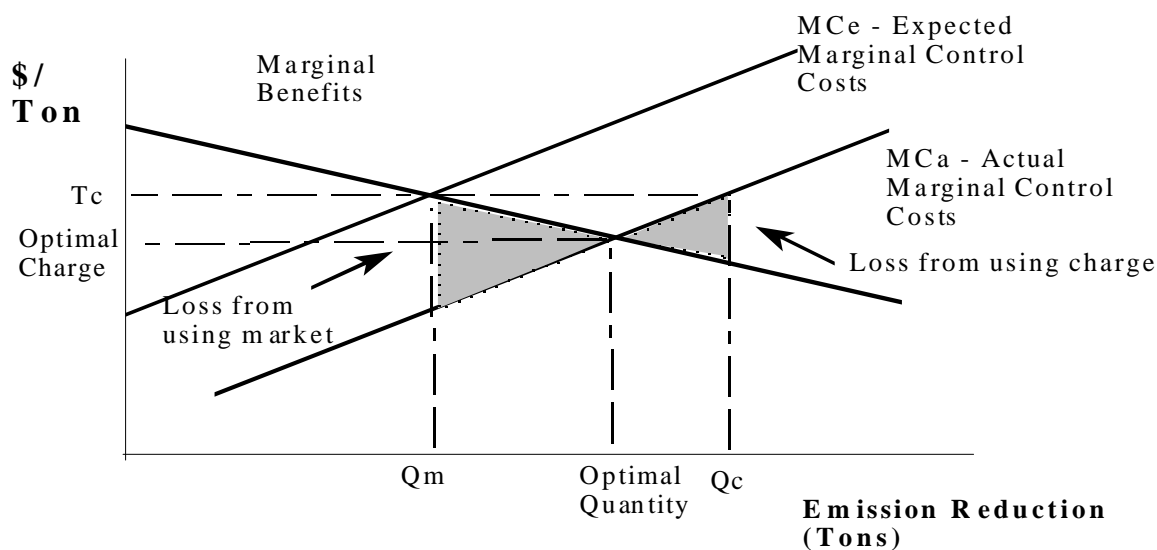


Figure 3: The Social Cost of Uncertainty with Flatter Marginal Benefits :

Compared to the steeper marginal benefit curve in Figure 2, the inefficiency from using a charge is less, and the inefficiency from a market is greater.

theory either one can achieve an efficient result. In practice, program selection (charges, markets, or a hybrid approach) and the net benefit from moving to an incentive program depend on the population of sources, information and implementation costs, regulatory constraints, and similar issues.

Uncertainty

For example, if we are uncertain about control costs under an incentive program, the preferred option depends on whether costs or benefits are thought to increase faster. If we suspect that the marginal benefit curve will fall quickly with a small increase in emissions then it is more important to have close control of emissions and a market is preferred. If the marginal benefit curve is very steep, then the cost of being wrong is much larger than if marginal benefits are relatively flat.

Figure 2 illustrates a situation where expected marginal costs (MCe) are higher than will actually be realized (MCa). The result of choosing the wrong charge (Tc) is a much larger reduction in emissions than is efficient. At the resulting quantity of emission reductions, Qc, marginal costs are much larger than marginal benefits. The resulting inefficiency, the large shaded triangle, is much larger than the inefficiency

that results from using a market (the small shaded triangle, which would be caused by the regulator choosing Q_m). But in Figure 3, marginal benefits don't increase as rapidly with emission decreases. The loss from using a charge shrinks, and the loss from setting the wrong quantity increases. In this case, a charge may be preferred. If marginal costs are expected to increase rapidly as emissions are reduced, then a permit allocation that is even slightly too low would impose large costs on society, and a charge would be preferred.

If frequent adjustments are required or expected to find the appropriate charge, sources may delay investment, making long-run firm response to the charge difficult to estimate. If firms do invest in controls in response to the charge, they risk having made unprofitable choices if the charge is subsequently lowered. For regions with sources that will require large scale investments to retrofit or replace polluting equipment, charge iteration could be very costly. Under an emission market program, districts may need to adjust permit allocations, but because the link between emissions and ambient air quality is more direct and better understood, such adjustments would probably be less frequent.

Growth and Change

With economic growth or inflation, a market of permits would automatically adjust by raising the price, because an more sources with greater output would bid up the emission credit price. Under a charge, as the economy grows sources will be willing to emissions will increase and to maintain the target the regulator must raise the charge. With technological improvements (which shift the marginal cost curve down), emissions will decrease under a fixed charge, while in a market the price will decline but emissions will not; as the market price drops, sources would increase their purchases of emission credits. Thus with economic change, the charge *de facto* sets a new ambient target — which may be appropriate if costs have shifted down — but the market does not. Markets give the regulator more control over maintaining a fixed target. Thus a charge may be more attractive for emissions such as greenhouse gases where an existing ambient target does not constrain policy makers, than for criteria pollutants.

Universe of Sources

The effectiveness of an emission market depends in large part on having sufficient participants to generate an active market. The greater the number and variety of sources, the more potential cost-saving trades there are. Some districts have relatively

few large firms. Not only does this make an active market less likely, these sources may be more successful at lobbying the district to get favorable initial allocations, delaying needed reductions. The extent of the market can be extended spatially, temporally, or across pollutants. For example, Sacramento Metropolitan AQMD has only about 30 major sources of NO_x (oxides of nitrogen), but the Sacramento Valley Air Basin, with nine air districts, has about 150 NO_x sources.⁶ While this might be enough support a market, trading coefficients or zones would have to be developed to account for ozone transport. Allowing interpollutant trades between NO_x and VOCs (volatile organic compounds), both of which contribute to ozone formation, could increase the number of participants by fifty percent. Whether developing this type of market would be beneficial would depend on accuracy of information about ozone formation and transport throughout the valley and whether a trading program could be designed that would not overburden participants with complexity.

In a domain with few sources, market prices can be affected by the action of firms with a large market share. Strategic manipulation is possible, but whether it is likely depends on the benefits to the firm. If new competitors can easily locate outside the air basin, or if credit prices are relatively low, it will be difficult to harm competitors through the use of market power. If the regulator is setting charges and must adjust the charge to attain the target standard, the same large sources could also behave strategically to manipulate the charge adjustment process.

Revenues

Either charges or marketable permits raise the question of use of revenues, unless the permits are allocated free of charge. Emission charge revenues can be used to reduce other, less efficient taxes. For example, revenues could be used to cut business fees or income taxes, which tend to discourage socially beneficial investment and labor. When used this way, charges can have both environmental and indirect economic benefits. However, if an agency relies upon the charge as revenue, it may be inclined to set the charge based on budget requirements rather than air quality concerns. Because budget needs would only by chance coincide with the efficient charge, this situation would reduce benefits from the program. Charges could also be made revenue-neutral by placing a charge on each unit of emissions, and rebating an amount based on average or percentage emissions reductions of the affected sources. With a large number of sources, a single source's actions would not affect the rebate and thus would not be

⁶ *Numbers are estimates based on facilities in the California Air Resources Board 1993 Emission Inventory with more than 2 tons of emissions annually.*

expected to distort the incentive of the charge.

EFFICIENCY OF CURRENT AIR QUALITY REGULATIONS

This section reviews the major regulations affecting large stationary sources with respect to consistency with the principles of efficiency discussed above.

Control Technology Standards

Although standards such as BACT are set as performance standards, they tend to treat all sources within a category the same. Uniform requirements for each source category limit the control options sources can choose from, despite large variation in cost effectiveness among sources. If regulators focus on sources within the category with the highest cost of control, they may overlook less expensive opportunities for control, while imposing disproportionately high costs on a few sources. The wide variance of control costs just among stationary sources illustrates the limitation of source specific standards and limits.

For industries that generate their own control strategies internally, the frequent revision of the standards discourages investment in developing new control options. For control technology developers and suppliers, revisions shorten the expected lifetime of new technologies.

These rules apply even when sources participate in RECLAIM or the national sulfur dioxide (SO₂) allowance market. For these sources, all emission costs are “internalized” — they must hold enough emission credits to cover all emissions — but the district prohibits certain options, such as replacing BACT-required equipment with less efficient controls. This limits the options available to sources for credit use and generation and thereby reduces the potential cost savings from trading. However, some theoretical work has identified situations in which an incentive program could increase costs if sources remove equipment and replace it with less controlling equipment.⁷ Thus there may be some economic justification for restrictions on removal of control equipment.

Recently the SCAQMD (South Coast Air Quality Management District) has begun to

⁷ Richard McHugh, “The Potential for Private Cost-Increasing Technological Innovation under a Tax-Based Economic Incentive Pollution Control Policy,” 61 *Land Economics* 58, February 1985.

look at ways to improve the incentives of the BACT process and make it more flexible. The SCAQMD proposes a fixed life BACT designation of two years. Even if a new more efficient product is designated BACT, an old product would remain marketable for the life of its designation.⁸ This reduces the risk to technology suppliers that regulatory fiat may render their products obsolete, but the BACT process would still arbitrarily limit the lifetime and expected return on investments in control technology.

New Source Review

While the New Source Review (NSR) offset program is often described as an example of a market-based program, that was not the original intent of the offset requirement and as a result the program differs significantly from a market for emission credits.

Offsets

State and federal laws require that in areas with serious and severe non-attainment status, the district or state be able to demonstrate that they have secured sufficient excess emissions reductions to offset all new emissions at the proper ratio. They do not require the source to purchase the offsets; the offset requirement is simply a program to maintain emissions at a set level and achieve further progress as necessary. It was the addition of the emission banking and bubbling policies (discussed below) that created economic incentives to reduce emissions.

The initial offset requirement for new sources is based on potential or “future expected,” not actual, emissions. The more capital the firm invests in control technology in building the plant, the fewer offsets it needs to buy, but once the permit is granted and the plant is in operation, the number of offsets purchased are irrelevant. The original purchase is a sunk cost; if the firm shuts down, it does not get the same quantity of offsets back. The district evaluates its actual emissions and discounts using control technology requirements, then issues offsets.

Prospective purchases of offsets could provide the incentives of a market transaction, if the permit required purchase of additional credits if emissions exceed the initial purchase, and allowed the source to sell surplus offsets. The crucial factor for ongoing efficient operating and investment decisions is marginal cost. From the point of view

⁸ *BACT Methodology Report: Recommendations of Policy Issues to Implement BACT, September 8, 1995, SCAQMD.*

of the firm's marginal cost — which must reflect environmental impacts for efficiency — it is no different whether it bought credits as offsets, or whether the air district endowed the firm with credits to allow it to build. The “no net increase” requirement by itself does not create appropriate incentives.

Emission Reduction Credit Creation

The ability to create emission reduction credits (ERCs) for emission reductions below control technology standards (e.g., BACT) does create some marginal incentives. If a firm chooses to retire equipment or improve control efficiency, it may bank those credits for sale or use as internal offsets. Owners of sources subject to NSR will minimize control costs within and across their own facilities, whether their plants were built before or after the offset requirement was instituted. However, ERCs may be heavily discounted at the time of use and are not related on a regular basis to the level of activity. The firm bears no marginal cost for increments of pollution below the NSR trigger. Because smaller sources are exempt, large sources will tend to bear a higher marginal cost than smaller sources.

The only demand for ERCs is from sources subject to NSR. For sources in sparsely populated areas there may be no expected buyers in the near future. If the firm has no near-term plans for expansion or retrofits, emissions that could be banked have no opportunity costs. This is in effect a facility-wide bubble, and provides incentives to minimize control costs at the facility, but there is no mechanism for minimizing costs across sources.

Each trade requires preapproval. Because of the regulatory costs and the limited extent of the market, most ERCs are used and generated within the same firm. While districts will consider the use of offsets generated from mobile or other types of sources, these types of trades are uncommon. Thus the market does not provide a strong opportunity cost signal to sources not covered by NSR.

Impact on entry and exit

For sources making a location decision, the difficulty of obtaining offsets raises the fixed costs of siting, especially in areas with little current industrial activity. If the supply of offsets is limited inappropriately (not based on relative marginal damages), areas that have had historically lower economic activity and have few large sources are put at a disadvantage compared to more industrialized areas. To the extent that regulations add economically inappropriate barriers that make it more difficult to build

new facilities, which will tend to be cleaner and more efficient overall, old plants will be protected from competition and the day when they are shutdown or rebuilt delayed. More flexible offset policies based on a solid understanding of regional air pollution patterns can mitigate these problems.

The bias against new plants versus old could become especially significant as potential new entrants decide whether, how, and where to enter the electricity generation market. Regulatory distinctions that don't reflect relative emissions damage can result in distorted generation choices and a less efficient marketplace.

Existing Facilities: Emission Limits and Bubbles

Most stationary source rules set performance standards based on information about available control options. While the source may choose the compliance strategy, these regulations leave little room to account for variations in cost across sources. Sources that face higher control costs than other firms in their category are likely to either devote resources to monitoring and lobbying for rules and exemptions that will treat them favorably, or later try to get a variance. Either alternative results in substantial resources being devoted to regulatory, rather than emission-reducing, activities. Small firms who do not have the resources or expertise to do this may find themselves at a competitive disadvantage only when it is too late.

Alternative compliance plan rules allow sources to propose strategies that will achieve emission goals at a lower cost, but this process can be time consuming and may require expertise that some firms don't have. Utilities have used this approach to develop system-wide emission bubbles or limits. This gives the utility an incentive and opportunity to minimize control costs across plants and creates a buyer for innovative, lower cost control technology. This is clearly an improvement over plant by plant restrictions, where the regulator does not know all the possible combination of control options and their associated costs.

These regulations will have to be adapted to restructuring, in particular after divestiture. Unless regulations are adapted innovatively some of the benefits from these rules could be lost. Those districts with limits on system-wide emission rates could simply keep the same rates for each plant or owner. Depending on how generation units are packaged for sale, those rates could be expensive to meet and because they will no longer be able to "pass-through" costs to ratepayers, powerplant operators may be less willing to invest in controls. These factors may result in new owners arguing

for a different allocation of emission reduction responsibility to avoid being put at a competitive disadvantage.

Because fewer tradeoffs are possible, control costs would vary across “subsystems” (plants with common ownership.) Even if all new subsystems could meet the original limit, total compliance costs would likely increase. Once a subsystem meets the emission rate, the only market incentive to make further improvements is to create ERCs.

To the extent that multi-site ownership exists, districts with a system-wide emission cap could use firm-wide caps. Control costs would increase relative to the savings under a system cap, but emissions could be held constant. The district would have to decide on allocations among firms. Subsystems that wanted to increase their production would have to make further investments in controls. While costs would be minimized within each subsystem, marginal costs would vary across subsystems.

The ability of powerplant operators to comply with specific permit limitations, especially caps, will depend on the flexibility of the bids submitted to the independent system operator (ISO). Under the utilities' power exchange proposal, the bid information submitted would include operating capability such as minimum and maximum output level, maximum and minimum run-time, and hours the unit is available. The price bid could be the price at or above which the generator is prepared to produce the next increment of energy. The bids may be submitted in discrete form or as a continuous curve.⁹ If operators can in effect bid their supply curves with constraints on maximum operation, they will probably have sufficient control to meet permit requirements. However, the bidding rules are still under development and the final form is uncertain.

Markets for Emission Credits

Emissions Budget Markets

An emissions budget or “cap and trade” program sets a regulatory limit on mass emissions from a discrete group of sources, allocates allowances to participating

⁹ *Joint Application of Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Southern California Edison Company for Authority to Sell Electric Energy at Market-based Rates Using a Power Exchange, April 29, 1996, pp 39-43.*

sources up to the limit, and permits trading of allowances in order to facilitate cost effective compliance with the cap. So far, those implemented appear to have been successful. For example, the cost of the acid rain program in which utilities trade SO₂ allowances is proving to be considerably lower than expected, in part because of the flexibility and innovation allowed under an emissions budget program.¹⁰

To date, RECLAIM trading credits (RTCs) are in surplus and most firms have not had to make emission reductions. However, the large volume of intrafirm trades suggest that many participants are finding savings from the added flexibility. The high concentration of allocations with Southern California Edison (SCE) and petroleum refining and extraction firms may affect credit prices. SCE currently holds about 11% of NOx trading credits. Chevron, UNOCAL, and ARCO each hold about 7%.¹¹ Because their market share is relatively large, their offers to sell through the credit auction can depress the market-clearing price, although the magnitude of the impact may not be large. Assuming SCE divests plants, market concentration will be reduced slightly, reducing its impact on prices. Market share by all sources would also be reduced under SCAQMD's proposals to expand the universe of sources allowed trade RTCs.

In contrast to NSR, RECLAIM puts new firms on a more equal footing with existing sources. They must purchase their credits rather than receiving an initial allocation as did existing sources. However, they purchase annual credits at a 1:1 ratio, rather than a lifetime supply at 1.2:1. Because it affects the source's marginal, not fixed, cost, this annual purchase provides a much stronger incentive to reduce costs than an offset purchase, and reduces entry costs. SCAQMD also provides nontradeable credits for new sources that meet "high employment, low emission" criteria. SCAQMD has met the no net increase requirement by reducing annual allocations for all sources, spreading emission reductions needed for attainment across both new and existing firms.

One limitation of RECLAIM in its current form is that it minimizes costs only for the sources in the program. To the extent that other smaller sources are more cost-effective to control, sources in RECLAIM are bearing a disproportionately high cost. To expand the market and improve efficiency, the SCAQMD is considering allowing credits

¹⁰ Dallas Burtraw, "Trading Emissions to Clean the Air: Exchanges Few but Savings Many," *Resources*, Winter 1996.

¹¹ Based on March 1996 SCAQMD data on RECLAIM activity. Actual percentages vary depending on the expiration year.

generated from area source emission reductions or other types of credits to be sold into or out of RECLAIM. Mobile source credits are already allowed.

The acid rain market for SO₂ is similar to RECLAIM, except that this program allows banking. This eliminates the incentive to dump or use credits at the end of an expiration period. Because SCAQMD fees have been based on RTC allocations held, firms have had an incentive to sell to avoid fees. SCAQMD is modifying this rule to base fees on actual emissions. A weakness of both RECLAIM and the SO₂ market is limited spatial differentiation. The SO₂ market is based on a single national cap, so variation in emissions damages by location is ignored. RECLAIM has only two trading zones to account for locational differences. The information requirements and costs of more precise spatial accounting may be prohibitive at present but as emission monitoring and modeling capabilities improve, regulators can enhance the efficiency of market structures.

Intercredit Markets

The SCAQMD is proposing an intercredit trading rule that would establish a mechanism for credits created under the ERC, mobile source credit, area source credit, and RECLAIM rules to be used interchangeably. The California Air Resources Board (ARB) is also developing a methodology for use by air districts to facilitate trading among stationary, area, mobile, and indirect sources. Intercredit trading would allow a balancing of control costs across a much wider pool of sources, promoting compliance flexibility, cost-saving opportunities, and technological advancements. Some restrictions would be placed on the flow of credits to maintain program integrity.

SCAQMD is also proposing an area source credit rule that would allow credits to be generated from unpermitted sources. Regulated sources could use the credits to comply with NSR, delay compliance with new rules, or use them as RECLAIM credits. This would reduce emissions from small unregulated sources, as well as expand the developing RECLAIM market.

Creation of credits by non-RECLAIM sources would be entirely voluntary. Because they are not capped they do not have as strong an incentive to reduce emissions as RECLAIM sources. However, for some small area sources like small combustion equipment, operating patterns might not vary that much even with a cap. Granting credits for cleaner, more efficient equipment might capture most of the benefits available, especially when monitoring and reporting costs are considered.

One option under consideration in the area source credit rule would be to grant conservation credits for installation of less energy-intensive equipment. This is straightforward for natural gas combustion equipment — the emissions are at the location of the conservation strategy. However, electricity conservation reduces emissions at powerplants, which in SCAQMD are already capped. Consumers purchasing electricity through the ISO pool would not be able to discriminate between RECLAIM and non-RECLAIM sources. While consumers using bilateral contracts could identify the source of their electricity, granting credits for conservation would require certainty that the customer continues to use the same (non-RECLAIM) generator over the life of the credit. In general, it would seem most efficient that credits be granted at the location of the emission decrease. As with many consumer products, the link between electricity production and consumption is sufficiently distant that the least-cost way to implement incentives is likely to be at the production end.

Granting credits for small, unpermitted sources in an efficient manner presents challenges for the district, but there are many control opportunities available at a lower cost than sources in RECLAIM. SCAQMD estimates that NO_x reductions from small combustion sources cost \$2,000/ton, compared to projected NO_x RTC prices of \$5,600 to \$14,200/ton. Intercredit trading will be especially valuable for VOC sources facing a new set of control measures. The Controls on VOC emissions vary in cost-effectiveness from under \$1,000/ton to \$18,000/ton or more, indicating large potential savings.¹² Bringing these options into the market can speed up compliance for SCAQMD as well as keep RECLAIM prices low, lower the cost of compliance for the district as a whole, and expand incentives to invest in control technology. If SCAQMD can successfully implement the area source credit rule, other districts (such as Ventura County Air Pollution Control District, which has a similar control measure for further study in its Air Quality Management Plan) may follow.

OPTIONS FOR MORE EFFICIENT REGULATIONS

One approach to improve upon the problems described above is to identify programs that are functionally better and will make equivalent or better progress, for even programs that aim to “internalize” can deviate in practice from the theoretical ideal. This may be because implementation costs require compromises, or to comply with federal and state requirements. While some requirements may be amenable to change or innovative interpretation, others will probably need to be accommodated.

¹² “*Intercredit Trading Study: Proposed Recommendations and Action Plan*,” January 1996, SCAQMD.

Below we review some of the possible strategies for improving the existing regulatory framework with respect to efficiency and consistency or conflicts with state and federal laws. In addition to NSR, control technology standards, and planning requirements, any incentive-based program must be consistent with EPA's Economic Incentive Program (EIP) rules (40 CFR Part 51), and with California Health & Safety Code 39620 (AB 1054). The EIP rules specify design criteria for incentive-based programs that EPA will consider approvable for the SIP (State Implementation Plan). AB 1054 (Sher) established requirements that districts who propose market-based programs to show that the new program will result in equivalent or better progress, at the same or lower cost, with no disproportionate impacts on any particular group of stationary sources.

Emissions Budget Market

An emissions budget program such as RECLAIM sets a limit on total emissions from a defined group of sources and allows the sources to buy and sell emission credits. Each source must hold enough credits to cover all its emissions. Well-designed emissions budget markets can offer the most certainty for both regulators and sources, but they require considerable start-up time and effort. They require agreement on the universe of covered sources, baseline emissions levels, the emissions cap and its rate of decline, the allocation of allowances, and monitoring and measurement protocols. Experience with the RECLAIM and acid rain programs has revealed that obtaining agreement on these points can take several years. While start-up costs should decline as experience is gained and monitoring costs fall, it may be difficult to capture all of the market-based opportunities to achieve air quality goals with reduced cost and greater flexibility with emissions budget programs.

For owners of plants in utility systems that have already negotiated system-wide emission limits with their districts, some form of emissions budget program might seem attractive. The caps, rates of decline, and monitoring procedures may be already agreed upon. Some operators would have experience in minimizing control costs across plants. Multi-plant owners may support caps because of the flexibility and cost savings they offer, even without trading. Rules with daily or annual caps could be amended to allow trading between plants with different owners. Conversion of system-wide emission rate limits to caps would require further negotiation. Powerplant owners could also trade rates rather than annual or seasonal emissions, but this approach provides less control to the district over total emissions.

Efficiency

A budget market might be system-wide (electricity generation only), or encompass the general population of stationary sources. A major concern for a generation-only market obviously is the number of participants and degree of competition. With few firms, very little interfirm trading might occur and the cost savings would be little more than with firm-wide bubbles. If the few existing generators refused to sell, new entrants could be excluded unless other sources of supply are allowed. However, the ability to exert market power can be reduced by technological innovation and by expanding the domain of the market. We must also consider the motivation to try to manipulate prices. For example, unless there are transmission line constraints that restrict supply into the district, powerplant operators could not gain electricity market share from credit market manipulation: other competitors who are outside that emission market could import electricity into the district. On the other hand, if the market zone is small and new firms must locate within that zone to be competitive (i.e., close to a port or railroad facilities), existing firms in that industry will benefit by refusing to sell credits. While market power may reduce the net benefits of a market, savings could still be significant.

An electricity-only market would be second-best in that it would result in distorted relative prices of electricity and other energy sources and would limit cost-saving opportunities. Emission market credit prices, and thus electricity prices, would be higher than in a broader market, because there are lower cost emission control options outside of the generation sector. However, as the use of credits expands, the markets could be linked or expanded.

Regulatory Compatibility

The procedure for gaining SIP approval for a budget market has been well mapped out by SCAQMD. As with RECLAIM, a budget program can be designed to meet control technology requirements for existing sources on aggregate basis, rather than source by source. Regular auditing can be used to determine whether emissions from new sources have been more than offset by declines from existing sources. To show compliance with state and federal regulations, SCAQMD conducted extensive air quality and socioeconomic modeling.

Feasibility

The major obstacle to a budget program is likely to be the high start-up cost. While agreeing on caps might not be as difficult with owners of powerplants, other sources cannot be expected to be willing to undergo the cost of setting up a market unless they

foresee higher compliance costs under the existing system. Many stationary sources have in recent years complied with new control technology standards and can make a strong argument that stationary sources have done their part. As districts approach compliance with the existing ambient standards and shift focus to mobile and area sources, stringent new rules for major sources do not seem likely. In this environment, support for large scale budget programs like RECLAIM is unlikely. However, if new attainment standards are adopted for particulate matter and ozone and districts must embark on a new round of control measures, this option may have more support, especially if it replaces other more costly measures.

Open Market

The “open market” approach for which EPA has developed a model rule is similar to SCAQMD's proposed area source credit rule. EPA's proposed Open Market Trading Rule for Ozone Precursors is a program states can choose to adopt which gives sources an additional compliance strategy.¹³ This option would not replace any existing control measures or permit requirements; districts may still need to decide on new permit terms for existing powerplants that change hands.

In this approach, with no cap on the level of total emissions, sources could choose to use credits as a compliance option but would not have to purchase or hold credits for all emissions. Open market trading programs would not require agreement on source or regional emission caps, on allocations, or on pre-established emissions measurement methodologies. Sources would trade discrete quantities of emission reductions already made, rather than emission rates that extend into the future, as with ERCs. Because no source caps or allocations would be used, more diverse and numerous types of sources, such mobile or area sources, could be included. EPA's rule specifies a 1.1:1 ratio for all trades; ten percent of credits in each transaction would be retired. Buyers would be not just those subject to NSR, but all sources subject to (more stringent) rules. Any source could generate credits for emission reductions that go below BACT. Credits for reducing output would be unlikely because no purchase would be necessary to increase output. Also, regulators would probably not wish to create an incentive for business shutdowns by granting credits.

New sources could comply with offset requirements by purchasing credits annually, although they could still choose to purchase them all initially. This would differ from

¹³ “Open Market Trading Rule for Ozone Smog Precursors,” 60 *Federal Register* 39668, August 3, 1995.

current NSR offset purchases in that if they reduced emissions below initial projections, they could sell surplus credits. Permits would contain a provision requiring the source to hold credits for at least the next year of operation. New sources would in effect operate under a cap and the cost of obtaining credits would be reflected in its electricity bid. As the pool of capped sources increases, the credit market becomes more active, and the district would move toward something like a budget program.

Efficiency

Under an open system, powerplants could earn tradeable credits for emissions resulting from additional controls or avoid new controls by purchasing credits, but emission control costs would not vary directly with production as they would under a cap. This weakens the link between emissions and the price of electricity compared to a cap. However, if the universe of sources is expanded sufficiently it could minimize costs across a much broader array of sources than the ERC mechanism currently does.

An active market is crucial so that existing sources perceive an opportunity cost for their emissions. If the market is thin, new sources bear both high search and purchase costs to acquire credits, and a higher operating cost to cover annual purchase costs. In this case relative marginal (bid) costs of existing versus new sources would not accurately reflect marginal emissions damage.

Both the model rule and the SCAQMD proposal would allow credits to be banked. This encourages reductions now, but creates a risk for the air district that attainment will be violated in the future. EPA believes the benefits of reductions now outweigh the risk from increased emissions in future years when the air is cleaner overall. Also, putting expiration dates on credits creates a “use it or lose it” situation for the holder. If the credit will expire at the end of the year and there is no willing buyer for it now, or prices are extremely low, a source might well increase emissions rather than husband the credit for sale in the future when prices may be higher.

Regulatory Compatibility

States that adopt the final version of EPA's model rule as a compliance option can expect immediate approval by the EPA. This would include regular audits to examine the program's effect on attainment progress. To the extent that the proposed program deviates from the EPA rule, a more detailed SIP amendment process would be required. Several states are already developing their own open market programs in

response to EPA's proposal. As EPA rules on the specifics of these programs, we will have a clearer picture of how open market programs can be used.

Feasibility

Because debate over caps and allocations can be avoided, an open market system would be much easier to implement than a budget program, and might generate less opposition. As the ARB and SCAQMD develop intercredit and other trading protocols, the rule development effort required by districts could be greatly reduced.

One concern may be for availability of credits to fund new sources. An alternative being evaluated by SCAQMD is to allow sources to contribute a trust or escrow account in lieu of purchasing credits. Funds would be invested in innovative technologies or programs. This could help reduce barriers to smaller firms where the market is not fluid and transaction costs are high. However, it could undercut the development of the market if use is not limited. For example, sources that need to make large purchases, which would push credit prices up, might prefer to contribute to the trust fund instead, so that market prices don't accurately reflect underlying supply and demand conditions.

Budget - Open Market Hybrid

Under this option, sources such as powerplants or other major sources would be capped, but uncapped sources could voluntarily supply credits or buy credits for compliance. This might increase the probability that generators and other major sources would be interested in an emissions budget program by expanding the supply of available credits. This would take advantage of the already agreed upon limits at powerplants, give powerplant operators flexibility, and boost the district credit market.

This could also entail trading between districts or basins (where justified by transport considerations) that have different types of trading regimes. By allowing trading across district or state lines, distortion caused by inconsistent programs can be minimized. Whereas in a thinly populated district prices might be unusually high, cross border trades can open up additional source of supply, equilibrating prices across districts. An example of this is the NO_x trading program that states in the northeast transport corridor are developing. Each state can develop its own emissions market program, but the states are working together to identify and agree upon program features that must be consistent across states to allow interstate trades.

Efficiency

Under this hybrid option, caps could be used where cost-effective, and smaller sources could participate voluntarily. This alternative could take advantage of the benefits of the open market approach for new sources (lowering entry costs), and make a stronger connection between emissions and electricity pricing.

Regulatory Compatibility

As with the open market option, approval as a compliance option may not be difficult if the proposed program is similar to EPA's proposed rule. However, if the caps are used to replace existing rules or as a control measure to achieve needed reductions, more rigorous analysis would be necessary.

Feasibility

Powerplants and other large stationary sources might object to being singled out for more stringent treatment. This approach would also require agreement on caps and allocations.

ISO Emission Charge

This would require the ISO to collect and monitor information about each generator's emissions, regardless of whether a pool transaction or a bilateral contract. The appropriate charge would be for each unit of emissions from each plant, adjusted for marginal damages based on location and other physical characteristics. If the ISO uses a pure marginal damage approach to calculate the charge, conflicts with district attainment plans could arise. To set a charge aimed at consistency with the SIP, the emissions reductions or level required from the charge would have to be specified for each powerplant in each district.

Efficiency

This alternative would minimize costs from the electricity industry, and provide correct incentives for investment in technology and firm entry and exit - in a partial sense. Competing forms of energy would not be charged, which would distort the relative prices of electricity and other energy sources. For all in-state electricity generation, control costs would be minimized and generation capacity would be dispatched efficiently, if charges throughout the state are set consistently.

To meet attainment standards, the regulator probably would have to adjust the charge periodically. However, control of emissions requires capital investment by firms. Once choices are made, they cannot easily undo those actions in response to a correction by the charge-setter. If firms anticipate that the current charge is temporary, they may delay making any control investment. On the other hand if the charge is not adjusted as economic activity increases, air quality may decline.

Market forecasting and socioeconomic analysis similar to what has been done for markets like RECLAIM would probably be relied upon to identify the appropriate charge. While emission market price forecasts have typically overestimated prices, the consequence of this is simply that program costs and socioeconomic impacts are overestimated. In the case of charges, the consequence of this overestimation would be selection of an initial charge that is too high, causing program costs to increase.

Regulatory Compatibility

Any charge approach raises the question of how it will integrate with existing NSR requirements. Just as under RECLAIM, where efficiency requires that both new and existing sources hold credits for all emissions, the charge must apply equally to all sources and all emissions. However, if plants pay a charge on all emissions with NSR also in force, marginal emission costs would be double counted. Firms would overinvest in reductions to reduce their charge bill and earn ERCs. Firms that have to buy credits to cover retrofitting would pay the additional charge, plus the cost of obtaining credits, thus paying more than their marginal damage. Given the cost and inefficiency of the ERC market, ERC prices might drop but they probably would not be negligible. Because firms would be paying out more than the damage they cause, investment in those industries would be inefficiently low, leading to further distortions in the economy and increasing the total cost of achieving the ambient standard.

Fortunately, two layers of regulation are not necessary. While EPA's EIP rules do not specifically discuss how offset requirements would be met with a charge program, EPA clearly considers an emission charge program a valid option for an incentive program. Under the EIP rules, projected emission reductions must be based on market analyses relating emissions to program design parameters: forecasting and audits could be used to show whether emission reductions from all sources in the program would be sufficient to offset increases from new sources. To ensure sufficient offsets to meet the no net increase requirement, revenues could be used to invest in emission reductions from sources unaffected by the charge. If revenues were not used for credit purchases, a generation-only program would weaken the ERC market.

Sources with banked ERCs would probably argue for a charge credit. Recently built or modified sources might also argue for credit for offset purchases on equity grounds. If this type of program is considered, such concerns should be addressed early to avoid discouraging economic activity while rule development is underway. If a remedy is necessary it would be best to minimize interference with the incentive benefits of the charge. A lump sum payment might be most efficient, but impractical. All sources could pay the emission charge, and any relief calculated separately. This would give some firms a financial advantage, but they would still have an incentive to reduce emissions to reduce their charge burden.

Feasibility

The Federal Energy Regulatory Commission (FERC) Notice of Proposed Rulemaking (NOPR) on open access makes the legality of an ISO charge questionable. Regardless, special legislation would be required, specifying who would set the charge and how funds would be allocated. Coordination with districts and ARB would be necessary to rewrite permits and rules, and to make the appropriate demonstrations to ARB and EPA. Because districts have primary responsibility for criteria pollutant attainment progress, they may be reluctant to delegate authority to set the charge. Districts might need or require the funds to be used for offsets or to replace fees, while other groups may argue for spending on conservation measures.

Compared to market approaches in which permit allocation can actually make some existing firms better off, charges will put new firms on a completely equal footing. For this reason, less support for charges might be expected. Charges represent a net wealth transfer away from existing sources.

District-Implemented Emission Charge

Rather than a central ISO charge, each district could choose to apply a charge per unit of emissions to generation sources only or to all sources.

Efficiency

The properties of this rule are similar to the ISO charge, except that a district-implemented charge would lay the groundwork for expansion to other sources. A charge implemented broadly throughout the air shed would be the most efficient charge approach. If each district set charges independently (using different methodologies),

inconsistencies and border issues could arise due to uncertainty of setting the appropriate charge. Coordination among districts would enhance this alternative.

Regulatory Compatibility

This requires the same analysis as the ISO charge to address offset requirements, but less coordination between energy and environmental agencies would be required. Designing a program to meet attainment goals could be easier because districts would have more flexibility to use revenues as needed.

Feasibility

This option places air district boards — composed primarily of local elected officials — in the position of setting and reviewing the charge rate. Because they will not know initially the appropriate charge to achieve ambient goals, they will have to revise the charge periodically or risk failing to meet attainment progress requirements. As with the ISO charge, existing sources might oppose this more strongly than a market approach.

System-wide Overhead Charge

A simpler charge would be a flat rate added to the pool price and collected by the ISO.

Efficiency

Of the alternatives discussed in this paper, a charge that is a function of output (i.e., \$/kWh) provides the weakest incentive to abate. In general, the charge will not vary with the firm's emissions. An investment in control technology may not reduce a generator's charge at all, and if it does, it would reduce the charge for competitors as well. The market-clearing price of the ISO auction would not reflect marginal emission damages. The net benefits of such a program could be negative, compared to the other alternatives described here, if the existence of the charge prevents more effective alternatives from being implemented. Given the investment that powerplants have already made in reporting, record-keeping, and continuous monitoring systems, there seems little reason to settle for this.

Regulatory Compatibility

This would require analysis similar to the ISO emission charge, but because of the weak link between the charge and emissions, obtaining approval for the SIP would be more difficult. Eliminating overlap with NSR offset requirements would also be more difficult.

Feasibility

There is significant question about the legality of this option because of the FERC NOPR. Otherwise, this alternative might be implemented by combining it with the public goods charge or otherwise collecting it through the ISO. Support may depend on the particular form of the charge.

CONCLUSION

Any of these alternatives (or any others that might be proposed) will take time to develop and can involve a major revision to the SIP. Meanwhile, districts that need to reevaluate current rules can prepare by continuing and expanding use of alternative compliance plan approaches. Because alternative compliance plan rules typically require improved record-keeping, monitoring, and reporting, as would the alternatives discussed above, they pave the way for a move to broader incentive programs. Sources that use this approach will begin to reap the benefits of more flexible programs and may be interested in ways to expand their use.

Each alternative above has benefits in allowing regulators to move toward air quality goals more efficiently, and promote a competitive market without having to know exactly what that market will look like. Before any particular approach is chosen, it must be analyzed in the specific context in which regulators will apply it. While most early experiences with incentive-based programs have been positive, there is still much to learn from experience, not just theory. Experimental, innovative programs by individual districts can be valuable tools not just for attainment for the district, but in learning how such programs work in practice.

**Witness Qualifications
for**

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